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(71) Applicant: **HITACHI METALS LTD**

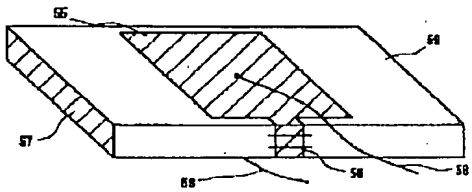
(72) Inventor: **ENDO HIROSHI**
SHIMODA YASUO
SADAMURA SHIGERU

(54) MULTILAYER PIEZOELECTRIC TRANSFORMER

(57) Abstract:

PROBLEM TO BE SOLVED: To prevent lowering of efficiency and short circuit by providing an electrode layer for input with a leading out part which faces the side face of a piezoelectric layer and sufficiently narrowing the width of the leading out part compared with that of the electrode layer.

SOLUTION: An inner electrode for input is formed in a piezoelectric body, except the leading out part, and is lead out to the side face of the piezoelectric body at the leading out part. The inner electrode is formed in the same shape so as to be superposed when viewed in the stacking direction. A pair of input electrodes 55 are formed on the upper and lower faces, and on the side face, a connecting electrode 56, which connects the leading out part which is lead out to the side face, is formed for continuity to respective upper and lower input electrodes 55. On the both edge planes of the multilayer piezoelectric transformer 59, output electrodes 57 are formed. Lead lines 58 are soldered to the upper and lower input electrodes 55 at the center. Thus, stress concentration while being driven is prevented and short circuit is prevented.



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CLAIMS

[Claim(s)]
[Claim 1] It is the laminating mold piezoelectric transformer which the laminating of a rectangle-like piezo electric crystal layer and the internal electrode layer for an input formed in the center section of this piezo electric crystal layer is carry out by turns, has the drawer section which faces said internal electrode layer for an input the side face of said piezo electric crystal layer in the laminating mold piezoelectric transformer with which the electrode for an output was formed in the both-ends side, and is characterize by for the width of face of this drawer section to are fully narrower than the width of face of said electrode layer.
[Claim 2] In the laminating mold piezoelectric transformer with which the laminating of a rectangle-like piezo electric crystal layer and the internal electrode layer for an input formed in the center section of this piezo electric crystal layer was carried out by turns, and the electrode for an output was formed in the both-ends side Said internal electrode layer for an input has the drawer section which faces the side face of said piezo electric crystal layer, and its width of face of this drawer section is fully narrower than the width of face of said electrode layer. And this drawer section the side face where the drawer section of the internal electrode for an input which is formed in one of end-face approach, and moreover counters rather than the medial axis of said internal electrode for an input is different respectively -- and the laminating mold piezoelectric transformer characterized by being pulled out at another end-face side.
[Claim 3] It is the laminating mold piezoelectric transformer which the connection electrode which connects said drawer section is formed in the side face of a layered product in claim 2, and is characterized by connecting this connection electrode to the input electrode of the vertical side of said layered product, respectively, connecting lead wire to this input electrode, and shifting and connecting the lead wire of this vertical side to a respectively different end-face side.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the laminating mold piezoelectric transformer used for electrical-potential-difference conversion.

[0002]
[Description of the Prior Art]In recent years, examination of power circuits, such as an inverter for back lights of the liquid crystal display using a piezoelectric transformer and a DC-DC converter, prospers. This reason is because fast miniaturization and thin shape-ization of a power circuit become realizable by adopting a piezoelectric transformer.
[0003]An example of the piezoelectric transformer for these power circuits is shown in drawing 10. This piezoelectric transformer is the Rosen mold piezoelectric transformer, for example, forms the pair of the input electrodes 4 and 6 prepared by silver printing etc. in the vertical side in the left half of [in drawing] the tabular piezo-electric ceramic component 2 which consists of a titanic-acid lead zirconate system (PZT), and has formed the output electrode 8 by the same approach also as a right-hand side end face. And polarization is carried out as the mechanical component in the left half of the piezo-electric ceramic component 2 shows the generation-of-electrical-energy section of a right

half to an arrow head in the die-length direction in the thickness direction, respectively.
[0004]thus, the formed piezoelectric transformer -- setting -- between an input electrode 4 and 6 -- the source 10 of alternating voltage -- the resonance frequency of the die-length direction of the piezo-electric ceramic component 2, and abbreviation -- if the alternating voltage of the same frequency is impressed -- mechanical vibration with this piezo-electric ceramic component 2 strong against the die-length direction -- being generated -- thereby -- the generation-of-electrical-energy section of a right half -- the piezo-electric effect -- a charge -- generating -- an output electrode 8 and an input electrode -- on the other hand, output voltage Vo arises between input electrodes 6. As shown in drawing 11 (A), there are half-wave length mode (lambda/2 mode) which resonates with the half-wave length in the die-length direction, and the one-wave mode (lambda mode) which resonates with one wave as shown in drawing 11 (B) in the oscillation mode of this piezo-electric ceramic component 2.
[0005]When driving on the same frequency, the component of the piezoelectric transformer driven in the one-wave mode turns into a component twice the die length of driving in half-wave length mode. For this reason, the piezoelectric transformer driven in half-wave length mode can consist of piezoelectric transformers driven in the one-wave mode small. On the other hand, if it thinks by the pressure-up ratio, a pressure-up ratio with the one-wave mode higher than half-wave length mode can be obtained.
[0006]The piezoelectric transformer of a laminating mold is also proposed to the piezoelectric transformer of the veneer mold shown in drawing 10. This laminating type of example is shown in drawing 12. Input electrodes 3 and 5 are formed in a drawing metacarpus front half, and, as for this laminating mold piezoelectric transformer component 1, the output electrode 7 is formed in an other end side. This input electrode is formed a piezo-electric ceramic ingredient and by turns also in the component 1, and each input electrode 3, 3a, 3b, 5, 5a, and 5b is connected by turns. That is, input electrodes 3, 3a, and 3b are connected with the connection electrode 9 of a side face, and input electrodes 5, 5a, and 5b are connected with the connection electrode 11 of other side faces. And this laminating type of piezoelectric transformer can constitute the piezoelectric transformer of a high pressure-up ratio as compared with veneer mold structure.

[0007]As mentioned above, when a miniaturization is taken into consideration, in order to obtain driving in half-wave length mode rather than the one-wave mode, and a high pressure-up ratio, it turns out that the piezoelectric transformer of a laminating mold is more advantageous than a veneer mold.

[0008]
[Problem(s) to be Solved by the Invention]From the above-mentioned thing, this invention persons have proposed previously the structure which has arranged the input electrode in the center section of the laminating mold piezoelectric transformer. This invention examines various structures of the internal electrode for an input of this center-section drive mold laminating piezoelectric transformer.
[0009]the top view showing the internal electrode structure of the example of a comparison in measure and drawing 5 is shown. The internal electrode 22 for an input is shifted by turns in the center section of the piezo electric crystal layer 21, and it constitutes from this example of a comparison so that one internal electrode may face side face of one of the two. The connection condition of the internal electrode after the laminating of this example of a comparison is shown in drawing 6. In this example of a comparison, since the internal electrode has shifted as shown in drawing 7, the part 23 which the internal electrode which should counter essentially does not counter arises in a side-face side. Polarization of this part will be carried out at a level with the cross direction of a component at the time of polarization, consequently it will generate vibration of the different mode from vibration of the part which the internal

electrode has countered at the time of a drive, and produces problems, such as decline in effectiveness.
[0010]Next, the top view showing the internal electrode structure of another example of a comparison in drawing 8 is shown. In this example of a comparison, although the internal electrode 27 for an input is formed in the center section of the piezo electric crystal layer 26, the notch 28 is formed by turns. By forming this notch 28 by turns, as shown in drawing 9, the connection electrode 28 is formed in a side face, and desired internal electrodes can be connected. In the case of this example of a comparison, the stress concentration at the time of a drive can be eased considerably. However, in a side face, if it drives under high humidity in order for the mutual internal electrode for an input to approach and to expose, the danger of connecting too hastily is produced and it is not desirable that minute dew condensation of a component front face (side face) causes an input-side short circuit immediately etc.
[0011]In view of the above-mentioned thing, in the laminating mold piezoelectric transformer of a central laminating mold, this invention examines the structure of the internal electrode for an input, and offers the laminating mold piezoelectric transformer which is not produced [short circuit / the decline in effectiveness,].
[0012]
[Means for Solving the Problem]It has the drawer section which, as for this invention, the laminating of a rectangle-like piezo electric crystal layer and the internal electrode layer for an input formed in the center section of this piezo electric crystal layer is carried out by turns, and faces said internal electrode layer for an input the side face of said piezo electric crystal layer in the laminating mold piezoelectric transformer with which the electrode for an output was formed in the both-ends side, and the width of face of this drawer section makes it narrower enough than the width of face of said electrode layer.

[0013]Moreover, the laminating of a rectangle-like piezo electric crystal layer and the internal electrode layer for an input formed in the center section of this piezo electric crystal layer is carried out by turns, and this invention is set to the laminating mold piezoelectric transformer with which the electrode for an output was formed in the both-ends side. Said internal electrode layer for an input has the drawer section which faces the side face of said piezo electric crystal layer, and its width of face of this drawer section is fully narrower than the width of face of said electrode layer. And this drawer sectionthe side face where the drawer section of the internal electrode for an input which is formed in one of end-face approach, and moreover counters rather than the medial axis of said internal electrode for an input is different respectively -- and it is pulled out at another end-face side. Moreover, the connection electrode with which this invention connects said drawer section to the side face of a layered product is formed, this connection electrode is connected to the input electrode of the vertical side of said layered product, respectively, lead wire is connected to this input electrode, and the lead wire of this vertical side is shifted and connected to it at the respectively different end-face side.

[0014]
[Embodiment of the Invention]The internal electrode for an input is formed inside, without making a side face face in the center of a rectangle-like piezo electric crystal layer, this invention constitutes it so that it may counter in the same field mutually, and it forms the drawer section with fully narrow width of face rather than an internal electrode. The width of face of this drawer section should just be width of face which enables connection between laminatings.
[0015]By this invention, by the shape of isomorphism, since the electrode which counters piles up, it can prevent polarization to a horizontal direction except for the narrow field of the drawer section. And since the internal electrode is formed in the interior except for the drawer section, it can prevent the short

circuit in a side face. Moreover, since only the electrode which should be connected on the side face has faced the side face, it can connect easily and there is also no danger of a short circuit.

[0016]Moreover, in this invention, since the drawer section of the internal electrode which counters is mutually shifted and arranged to the reverse end-face side, and the lead wire for external connection was shifted similarly and arranged, the short circuit in the drawer section or lead wire has been prevented.

[0017]

[Example]The perspective view of one example concerning this invention is shown in drawing 1. Moreover, the top view showing the appearance of the internal electrode of this example is shown in drawing 2. As shown in drawing 2, the internal electrode 52 for an input and the drawer section 53 are formed of the pattern printing of conductors (Ag/Pd paste etc.) on the green sheet 51 of piezo electric crystal porcelain, and this example carries out the predetermined number-of-sheets laminating of this green sheet, sticks by pressure and calcinates it, and obtains a laminating mold piezoelectric transformer. Except for the drawer section 53, the internal electrode 52 for an input of this example is formed in the interior of a piezo electric crystal, and is pulled out by the side face of a piezo electric crystal in that drawer section 53. And except for the drawer section 53, the internal electrode 52 for an input is seen in the direction of a laminating, and it is isomorphism-like, and it is formed so that it may overlap.

[0018]The input electrode 55 of a pair was formed in the vertical side, the connection electrode 56 which connects the drawer section pulled out by the side face was formed in the side face, and this example has flowed in the up-and-down input electrode 55, respectively, as shown in drawing 1. Moreover, the output electrode 57 is formed in the both-ends side of this laminating mold piezoelectric transformer 59. Moreover, lead wire 58 is soldered to the up-and-down input electrode 55. At this time, lead wire 58 is soldered in the center section of an input electrode 55.

[0019]The perspective view of another example concerning this invention is shown in drawing 3. Moreover, the top view showing the appearance of the internal electrode of this example is shown in drawing 4. As shown in drawing 4, the internal electrode 62 for an input and the drawer section 63 are formed of the pattern printing of a conductor on the green sheet 61 of piezo electric crystal porcelain, and this example carries out the predetermined number-of-sheets laminating of this green sheet, sticks by pressure and calcinates it, and obtains a laminating mold piezoelectric transformer. Except for the drawer section 63, the internal electrode 62 for an input of this example is formed in the interior of a piezo electric crystal, and is pulled out by the side face of a piezo electric crystal in that drawer section 63. And except for the drawer section 63, the internal electrode 62 for an input is seen in the direction of a laminating, and it is isomorphism-like, and it is formed so that it may overlap.

[0020]In this example, rather than the medial axis 64 of the internal electrode 62 for an input, shift and form and the drawer section 63 is in an end-faces [one of] side, and between the internal electrodes 62 for an input which moreover counter, that drawer section 63 is an opposite side face mutually, and is arranged to the opposite end-face side.

[0021]The input electrode 65 of a pair was formed in the vertical side, the connection electrode 66 which connects the drawer section pulled out by the side face was formed in the side face, and this example has flowed in the up-and-down input electrode, respectively, as shown in drawing 3. Moreover, the output electrode 67 is formed in the both-ends side of this laminating mold piezoelectric transformer 69. Moreover, lead wire 68 is soldered to the up-and-down input electrode 65. In this example, since lead wire 68 is also shifted and connected in addition to having shifted the drawer section 63, it turns out that the effectiveness of preventing the short circuit between input electrodes is high.

[0022]It is the piezoelectric transformer of the central drive mold which has arranged the input electrode in the center of a component, and, moreover, the laminating mold constitutes from two examples besides described. This drive method constituted the piezoelectric transformer of 1/2lambda molds. Thereby, the piezoelectric transformer of a small and high pressure-up ratio has been constituted.
[0023]
[Effect of the Invention]The laminating mold piezoelectric transformer of structure which prevented the stress concentration at the time of a drive, and prevented the short circuit by this invention can be constituted, and the piezoelectric transformer which moreover has a small and high pressure-up ratio with a central drive mold can be obtained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is the perspective view of one example concerning this invention.

[Drawing 2]It is the top view showing the appearance of the internal electrode for an input of the example of drawing 1.
[Drawing 3]It is the perspective view of another example concerning this invention.
[Drawing 4]It is the top view showing the appearance of the internal electrode for an input of the example of drawing 3.
[Drawing 5]It is the top view showing the appearance of the internal electrode for an input of the example of a comparison concerning this invention.

[Drawing 6]It is the perspective view of the example of a comparison of drawing 5.
[Drawing 7]It is the sectional view of the example of a comparison of drawing 5.

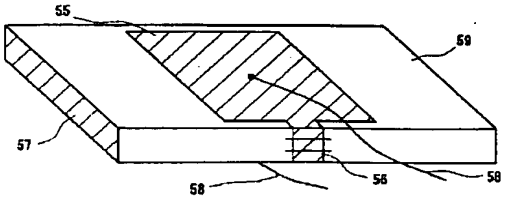
[Drawing 8]It is the top view showing the appearance of the internal electrode for an input of another example of a comparison concerning this invention.

[Drawing 9]It is the perspective view of the example of a comparison of drawing 8.
[Drawing 10]It is the perspective view of the conventional example.
[Drawing 11]It is drawing having shown the situation of vibration in the case of half-wave length mode and the one-wave mode.
[Drawing 12]It is the perspective view of the conventional example.

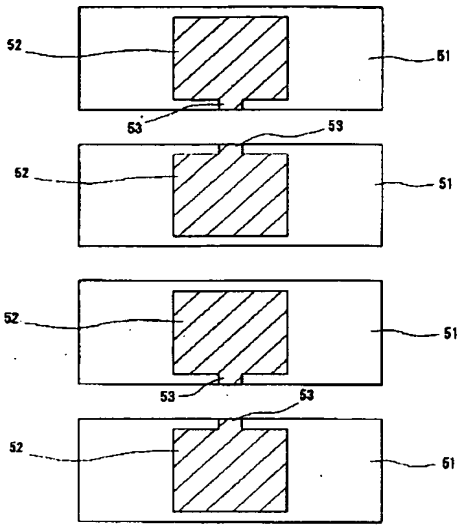
[Description of Notations]
51 61 Green sheet of piezo electric crystal porcelain (piezo electric crystal layer)
52 62 Internal electrode for an input
53 63 Drawer section
55 65 Input electrode
56 66 Connection electrode
57 67 Output electrode
58 68 Lead wire
59 69 Laminating mold piezoelectric transformer
64 Medial Axis

DRAWINGS

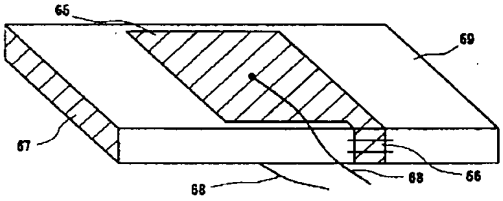
[Drawing 1]



[Drawing 2]



[Drawing 3]



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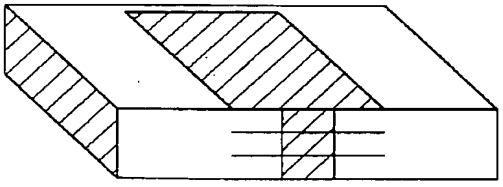

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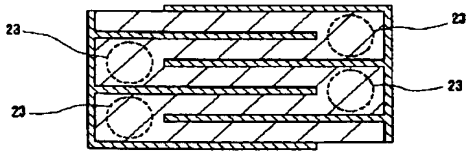
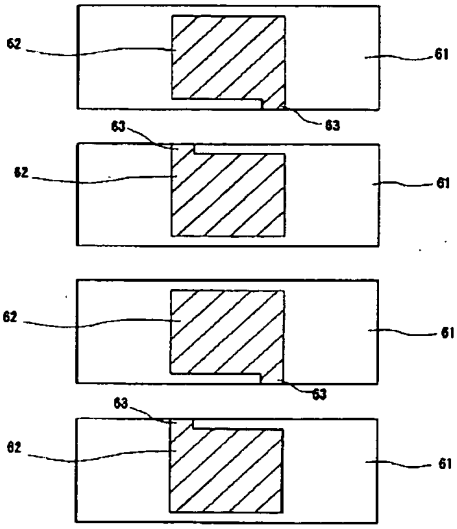
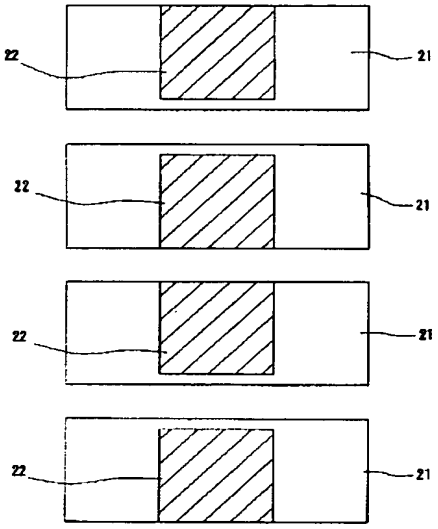


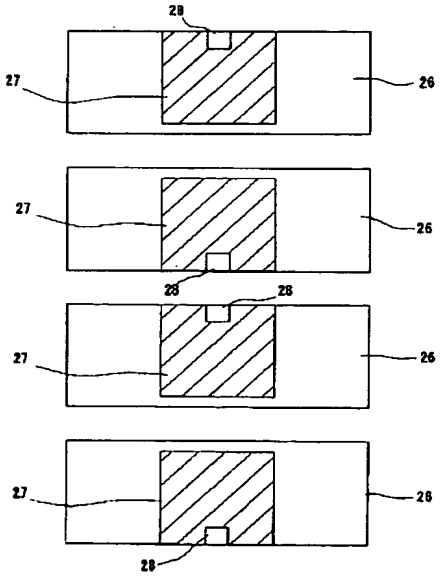
[Drawing 4]



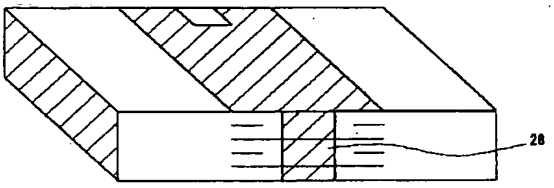
[Drawing 5]



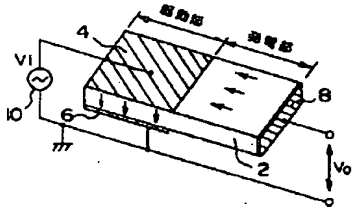
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Drawing 11]

[Drawing 12]